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Remote Visual Inspection of Gun Tubes

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the system. A two-step procurement was initiated following the establishment of design criteria and preparation of a specification. The quotations that were received for the acceptable proposals were exceedingly high. It was determined that the automation aspect of the design was the predominant factor for the high quotations. The additional funds needed to pursue a purchase could not be justified nor could the cost of rewriting the specification for re-submittal to procurement. The project was consequentially cancelled with the final report offering suggestions and recommendations for any future work in this area.

MATERIALS TESTING TECHNOLOGY PROGRAM (AMS 4931)

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ABSTRACT

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INTRODUCTION

Some previous investigations[1&2] in remote visual inspection presented advantages of visual inspection of cannon bores by means of Closed Circuit Television (CCTV) techniques. Most of these advantages are still current and can be realized today. Briefly, some of these advantages are:

a. Simplify inspection tasks by reducing inspection time.

b. Eliminate human error due to eye fatique.

c. Provide for group evaluation by a technical team.

d. Enable defects to be permanently recorded using available video tape recorders.

Although these advantages have merit, they were accompanied with the following design disadvantages:

a. The need for an inspection apparatus the length of which is at least as long as the length of the object to be inspected. Lengths up to and including 20 feet had to be considered.

b. The high magnification of the system, in some cases, made relocation of a discovered defect a tedious task.

The scope of work for this project was:

a. To prepare a specification detailing equipment requirements.

b. Procure the system.

c. Test the system for conformance to the specification.

d. Incorporate the final end item into the manufacturing production line.

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[1]Compisi, V.G. and McKeon, R.W., "Investigation of Advanced Methods of Visual Inspection of Cannon Tube Bores, "WVT-QA-7001, Watervliet Arsenal, Watervliet, NY, October 1970.

[2]Compisi, V.G and McKeon, R.W., "Advancement of Closed Circuit TV Gun Tube Inspection, "WVT-QA-7401, Watervliet Arsenal, Watervliet, NY, March 1974.

The major difference in this project compared to past efforts would be to minimize the disadvantages stated above and to update the system design with solid state electronics and state-of-the-art video technology.

PRINCIPLE AND DESIGN CRITERIA

A CCTV system will usually incorporate (as a minimum):

a. CCTV camera, usually of a vidicon type image tube.

b. A video monitor (high resolution, low resolution or both).

c. Viewing optics.

d. Illuminating apparatus.

There are essentially two separate, yet similar, approaches. In the most common approach, the view is picked up by the camera at the inspection site. In the second approach the view is first carried back to a remote site (via a borescope or some other carrier lens assembly) and then picked up by the camera. Both concepts were explored and each experienced some magnitude of success.

SYSTEM CONCEPT

The system essentially has three major sub-systems:

a. Scanning Head - A head with the required optics, television electronics and illuminating devices that will permit imaging of the bore at any particular location.

b. Translating Mechanism - A mechanism that will drive the scanning head downbore to a selected axial location and then rotate it to a desired angular position within the tube bore.

c. Viewing Station - Composed of a high resolution monitor, displays, controls, video amplifiers and tape recorder for viewing and recording information received from the scanning head.

PROCEDURE

The completed specification was submitted to Procurement for solicitation under a two-step purchasing procedure and six companies responded with proposals.

STEP ONE - PROPOSAL EVALUATIONS

After evaluation of all the proposals, it was determined that of the six submitted, only two were technically acceptable. Most of the unacceptable proposals deviated from the optics design and TV specifications, and/or lacked sufficiently detailed information. The two acceptable proposals were basically similar. The following descriptive summaries of the three major subassemblies note the differences between the two proposals submitted from company A and company B respectively.

a. Company A's proposal included the following:

(1) Scanning Head and Illumination: Two heads, one to provide a 90° viewing angle and another to provide a 180° viewing angle. Company A is confident that these two heads would do the job and based their judgment on previous successful work.

(2) Translating Device: Company A discussed two options: A crawler that would track down the bore with the heads or a push drive that would push the heads down the bore. The push drive would be a mechanical, collapsable antenna-like

device. Although the crawler would eliminate the required extra room that would be needed with the push type drive, Company A was very critical of pursuing the crawler approach based on some unsuccessful efforts observed from a cooperative project with another comppany in this area.

(3) Viewing Station: This station would be composed of a portable cart that would not only serve as a viewing station and control console, but also as a housing for the translating device and heads. All the components were in conformance with the specification.

b. Company B's proposal seemed to lean toward a more advanced technical approach. Their proposal included:

(1) Scanning Head and Illumination: Company B offered a head that would have the capability of rotating while traversing down the tube. Rotation would be at the same rate as the twist of rifling, thus allowing a view that would not cause a vertiginous effect on the operator. This effect is due to viewing a series of lands and grooves passing across on the monitor as a rotationally fixed head is passed down the bore.

(2) Translating Device: A few proposals for this subsystem were submitted:

(a) A crawler

(b) A telescopic push drive

(c) A "Space Boom"

The description of the crawler is much like the description of the crawler that company A proposed with the additional benefit of coordinated rotation to view one set of lands and grooves while traversing through the tube. The telescopic drive is very similar to company A's push drive proposal. Company B, however, described this concept in a little more detail. The "Space Boom" concept is based on a collapsable beam that can be rolled up into a container yet experiences very good stiffness properties upon its deployment. This commercial unit was anticipated by WVA to be an expensive concept.

(3) Viewing Station: This station would be portable with all the necessary control and viewing instrumentation on board. All the components were in conformance with the specification.

STEP TWO - INVITATION TO BID

Procurement was informed that WVA evaluated the proposals and would like a request for bid from the two acceptable proposals. The bids were received and were $195,833 (Company A) and $554,433 (Company B). These enormously high bids were not expected. The low bid was about four times the amount that was allocated in the project for procurement. Although it was desirable to be able to procure one of the systems, the additional cost could not be justified based on the uncertainty of the results. The project was subsequently cancelled.

CONCLUSIONS AND RECOMMENDATIONS

a. After the bids were received, WVA inquired into the reasons for the high prices from both companies. Both companies major reasons were quite similar, i.e, the automation of the system has not been developed by anyone yet and such development would be time consuming and expensive. Should the first prototype not work correctly, they would have to start the development over again. To cover this possibility, the companies included extra costs in their bids.

b. The technology exists to fabricate a reliable and worthy visual inspection system that would ease the inspection, evaluation and documentation of medium and large caliber cannon bores. This technology has been developed to an extent. The technology exists to automate this system but it has not been developed to any significant degree. Any future endeavors in this area might consider a two-step approach. The first step would be to produce an inspection system as desired without the automation. Some sort of manual drive system could be incorporated. At a later date, the automation could be incorporated into the system under another project. Since the majority of the total system would be available for engineering experimentation, much time could be saved in the development of the automation aspect.

c. There has been some promising results in recent work with computerized video enhancement techniques. These techniques enhance the video image by being able to offer control of several variables

of the the imaging process in such a way that particular attributes of an image can be highlighted thereby aiding in image clarity. These special features have just recently become economically practical.

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